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Study the Effects of Dopamine on Oliguric Patients Referred to Amir Kabir Pediatrics Hospital of Arak University of Medical Sciences, Iran 2017 - 2018

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Abstract

Acute kidney injury (AKI) or acute renal failure is a clinical manifestation in which the kidneys are unable to preserve the normal homeostasis of water and electrolytes. To evaluate the effects of low dose dopamine to improve the renal functions in children, 3 μg/kg/min, IV infusion of dopamine was prescribed. The results of this study showed that low dose dopamine improved the serum creatinine concentration and corrected the time of appropriate urine volume, however, it was not effective on the serum electrolytes (Na, K, Bicarbonates, BUN) and the glomerular filtration rate (GFR).

Keywords: Dopamine, Oliguric Patients, Oliguria

1. Background

Acute kidney injury (Acute renal failure) is a clinical manifestation in which the kidneys are unable to preserve the normal homeostasis of water and electrolytes of the body (1). Acute kidney injury (AKI) is appeared as oliguria, anuria, or may be exhibited with the normal volume of urine. Oliguria, urine excretion less than 400 mL/day, is the most prevalent sign of acute kidney injury. Anuria, urine excretion less than 50 mL/day, and AKI with the normal urine output, are not as prevalent as oliguria.

An abbreviation word (RIFLE) is used for pediatric classification of acute kidney injury. R (risk), implies a decrease in renal clearance up to 25% and urine output less than 0.5 mL/kg/h for eight hours. I (injury), fall in renal clearance up to 50% and urine output less than 0.5 mL/kg/h for 16 hours. F (failure), 75% decrease of urine clearance or 35 mL/min/1.73m^2 of serum clearance and urine output less than 0.3 cc/kg/h or being anuria for 12 hours. L (loss), loss of renal function for more than four weeks. Finally, E (end stage), which implies permanent renal failure for more than three months (2).

Acute kidney injury commonly has three pre-renal, renal, and post renal main sources. Pre renal AKI comes from inadequate perfusion of the renal tissues due to renal artery obstruction or stenosis. The renal part of AKI is caused by acute damage or destruction of the renal tissues and the post renal AKI comes from obstruction of ureter or any other parts of urine out flow.

In patients with pre renal azotemia, sodium concentration of urine will be decreased to less than 20 meq/L while the urine sedimentation remains normal. Other studies showed that fractional excretion of sodium (FE Na) depends on glomerular filtration rate and the amount of sodium intake (3).

Many drugs are used to improve the prognosis of the AKI. Diuretics are commonly prescribed to correct the volume of the body fluid, however, their role in reducing the required time for treating the AKI have not yet been established (4). Low dose dopamine (1 - 3 μg/kg/min), due to its effects on dopaminergic receptors of the kidneys, is usually used to dilate the renal arteries and increase the urine output, whereas high dose dopamine (10 - 20 μg/kg/min), by stimulating α and β sympathetic receptors, causes constriction of renal, mesenteric, and peripheral arteries. Increasing the peripheral vascular resistance and cardiac oxygen demand may lead to myocardial ischemia (5).

It is suggested that imbalance renal medullary oxy-

gen supply/demand relationship can cause ischemic acute kidney injury. Infusion of dopamine at 2 - 4 μg/kg/min increases the renal oxygen supply by a pronounced pre- and post-glomerular vasodilation (6). Infusion of low dose dopamine is normally associated with an increase in creatinine clearance and reduction in erythropoietin (EPO) levels in patients with IgA nephropathy. The patients who showed a fall in EPO had less proteinuria and lower serum uric acid and lower blood pressure (7).

2. Methods

This study was carried out as an un-blinded clinical trial at the Arak Amir Kabir Pediatrics Hospital of the Arak University of Medical Sciences, Iran. Among the patients younger than 15 years' old, whom were admitted due to acute kidney injury and had oliguria, 120 subjects have been selected for this study. Previously, the oliguric patients with AKI, who had any other kinds of chronic kidney diseases or malignancy, have been excluded. The selected patients have been randomly divided into two 60 experimental and 60 control groups without considering their gender (Table 1). For each patient of the experimental group, low dose dopamine (3 μg/kg/min) IV infusion were prescribed and the control group received maintenance serum therapy by infusion of normal saline. The glomerular filtration rate (GFR), serum Na, K, BUN, Cr, and bicarbonate, prior to intervention for the experimental and the control groups, were measured. The serum concentration of Na, K, bicarbonate, BUN, Cr, daily urine volume, onset of urination, and GFR for both experimental and control groups 48 hours' after intervention were measured and compared. The time of appropriate volume of urine for both groups that was considered at least 0.5 cc/kg/h for the patients older than one year and 1 cc/kg/h for the patients younger than one-year-old, 48 after intervention, were also measured and compared.

Table 1. Number and Sex of the Experimental and Control Groups

Groups of Study/Sex	No.	Percents
Experimental		
Female	28	46.7
Male	32	53.3
Control		
Female	34	56.7
Male	26	43.3

3. Results

Measured serum electrolytes (Na, K and Bicarbonates), BUN (blood urea nitrogen), GFR (glomerular filtration rate), the onset of urination, and the volume of urine of the experimental and control groups were shown in the Table 2. As the statistical analysis in Table 3 implies, the differences of serum creatinine (P value = 0.022) and the time of urine volume improvement (P value = 0.008) between the experimental and the control groups are significant, however, this difference for the time of the first urination (P value = 0.906) and serum Na concentration (P value = 0.233), serum K concentration (P value = 0.339), serum bicarbonate (P value = 0.712), urea concentration (P value = 0.339), and the GFR (P value = 0.119) between the experimental and the control groups are not significant.

In Table 2, in some parameters may have small differences in the number of participants. Those were due to the deletion of some incorrect information and exclusion of them from statistical analysis. These small differences in the number of participants did not affect the results.

4. Discussion

AKI which was previously called acute renal failure (ARF), is a clinical manifestation in which the kidneys are unable to preserve the normal homeostasis of water and electrolytes of the body. Acute kidney injury is appeared as oliguria, anuria, or may be exhibited with the normal volume of urine. Oliguria is the most prevalent sign of acute kidney injury. Low dose dopamine (1 - 3 μg/kg/min), due to its effects on dopaminergic receptors of the kidneys, is usually used to dilate the renal arteries and increase the urine output. This study also showed that infusion of 3 μg/kg/min of dopamine to improve the serum creatinine and the time of urine volume improvement was significantly effective. Zhang and Harris (5) in a literature review, showed that intrarenal dopaminergic system plays an important role in regulation of the blood pressure. These reviews seem to confirm our findings regarding the effects of low dose dopamine to improve the function of kidneys. Redfors et al. (6) in a clinical trial study, stated that low dose dopamine, by decreasing the renal vascular resistance, increases renal oxygenation without any increase in Na reabsorption. This study also stated that the use of low dose dopamine in AKI patients seems to be helpful. The study of Sulikowska et al. (7) regarding the effectiveness of low dose dopamine to increase the creatinine clearance and the results of the investigation of Protasiewicz et al. (8) which indicated that internal bolus of dopamine is more effective than papaverine to increase the renal blood supply,

Table 2. Measured Parameters of the Experimental and Control Groups Were[a]

Group Statistics	N	Mean	Standard Deviation	Standard Error Mean
Time of first urine excretion				
Case	58	15.0517	18.18537	2.38786
Control	60	14.6667	17.09040	2.20636
Urine volume improvement				
Case	55	5.1636	7.14082	0.96287
Control	60	3.7167	0.86046	0.11109
Time of urine volume improvement				
Case	52	108.0769	119.93525	16.63203
Control	60	62.0000	20.31948	2.62323
Na^+ before intervention				
Case	59	141.0881	12.89465	1.67874
Control	60	137.4417	4.42364	0.57109
Na^+ 48 hours after intervention				
Case	59	140.8542	10.16545	1.32343
Control	60	137.9000	2.50220	0.32303
K^+ before intervention				
Case	59	4.1814	0.85354	0.11112
Control	60	4.1358	0.56711	0.07321
K^+ 48 hours after intervention				
Case	60	4.5885	4.44834	0.57428
Control	60	4.0350	0.39950	0.05158
$H^- CO_3$ before intervention				
Case	60	19.6400	6.24913	0.80676
Control	60	19.7500	2.44211	0.31527
$H^- CO_3$ 48 hours after intervention				
Case	60	20.8400	5.17482	0.66807
Control	60	21.1050	1.99477	0.25752
BUN before intervention				
Case	59	52.3508	75.73341	9.85965
Control	60	25.3367	15.02994	1.94036
BUN 48 hours after intervention				
Case	59	44.9627	70.91704	9.23261
Control	60	19.8167	8.67002	1.11929
Cr before intervention				
Case	59	2.9083	13.27074	1.72770
Control	60	0.58005	0.47798	0.06171
Cr 48 hours after intervention				
Case	60	1.1072	1.89457	0.24459
Control	60	0.5177	0.46434	0.05995
GFR before intervention				
Case	59	61.0934	43.28708	5.63550
Control	60	74.1710	20.99378	2.71029
GFR 48 hours after intervention				
Case	60	64.9588	47.87109	6.18013
Control	60	83.5378	20.91299	2.69986

[a] $H_0: \mu_1 = \mu_2, H_1: \mu_1 \neq \mu_2$.

confirm the findings of this study, which showed the effectiveness of low dose dopamine to correct the time of urine volume and improve the serum creatinine concentration. The study of Lauschke et al. (9) concerning the effects of low dose dopamine on the patients with acute renal injury and the patients without AKI, showed that dopamine in patients more than 55 years old increases the vascular resistance and worsens renal perfusion, on the contrary in children causes renal vascular relaxation and improve renal perfusion. Since our study at the Arak pediatrics hospital was focused on the children, the findings of Lauschke et al. also confirms the results of our study, which stated that in children, low dose dopamine is effective to improve their renal function.

Table 3. Compares the Analytical Results and Co-variance Analysis in Experimental and Control Groups

Variants	Levels of Significant
Time of first urine excretion	0.906
Urine volume improvement	0.141
Time of urine volume improvement	0.008
Na^+ after 48 hours[a]	0.233
K^+ after 48 hours	0.339
$H^- CO_3$ after 48 hours	0.712
BUN after 48 hours[a]	0.339
Cr after 48 hours	0.022
GFR after 48 hours[a]	0.119

[a] ANCOVA.

4.1. Conclusion

This study showed that use of low dose dopamine (3 μg/kg/min) IV infusion in children improves the required time for urine volume correction and the serum creatinine concentration.

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Footnotes

Authors' Contribution: Study concept and design: Parsa Yousefichaijan, Vahab Ghanbari Sheldareh, Yazdan Ghandi; analysis and interpretation of data: Vahab Ghanbari Sheldareh, Parsa Yousefichaijan, Yazdan Ghandi; drafting of the manuscript: Vahab Ghanbari Sheldareh; critical revision of the manuscript for important intellectual content: Vahab Ghanbari Sheldareh, Parsa Yousefichaijan, Yazdan Ghandi; statistical analysis: Danial Habibi.

Conflict of Interests: No conflict.

Ethical Considerations: IR.ARAKMU.REC.1395.222.

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